

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

MED 2 1115

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

10/030738

INTERNATIONAL APPLICATION NO.
PCT/FI00/00556INTERNATIONAL FILING DATE
21/06/2000PRIORITY DATE CLAIMED
09/07/1999TITLE OF INVENTION
FILTERING UNIT AND METHOD OF SEALING SAMEAPPLICANT(S) FOR DO/EO/US
Teppo J. NURMINEN; and Martin J. STILL

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☐ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). - (Unsigned)
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
WO 01/03813
PCT/ISA/210
PCT/IPEA/416

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Post Office to Addressee" service under 37 C.F.R. 1.10 on the
date indicated above and is addressed to:
Assistant Commissioner for Patents Washington, D.C. 20231.

Hilary M. McNulty
By: Hilary M. McNULTY

21. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):**

Neither international preliminary examination fee (37 CFR 1.482)

nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO

and International Search Report not prepared by the EPO or JPO..... \$1040.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =**CALCULATIONS PTO USE ONLY**

\$ 1,040.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$
Total claims	17 - 20 =	-	x \$18.00	\$
Independent claims	4 - 3 =	1	x \$84.00	\$ 84.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$280.00	\$

TOTAL OF ABOVE CALCULATIONS =

\$ 1,124.00

☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.

+

SUBTOTAL =

\$ 1,124.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

\$

TOTAL NATIONAL FEE =

\$ 1,124.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

\$

TOTAL FEES ENCLOSED =

\$ 1,124.00

Amount to be refunded:

\$

charged:

\$

a. ☒ A check in the amount of \$ 1,124.00 to cover the above fees is enclosed.b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 06-0308. A duplicate copy of this sheet is enclosed.d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.**SEND ALL CORRESPONDENCE TO:**

Thomas E. Kocovsky, Jr., Esq.
 FAY, SHARPE, FAGAN, MINNICH & MCKEE, LLP
 1100 Superior Avenue, Seventh Floor
 Cleveland, OH 44114-2518
 (216) 861-5582
 TKocovsky@faysharpe.com

SIGNATURE

Thomas E. KOCOVSky, Jr.

NAME

28,383

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:) Examiner: Unknown
T. NURMINEN, et al.)
Serial No.: Unknown) Art Unit:
Filed: Herewith)
For: FILTERING UNIT AND)
METHOD OF SEALING SAME)
Attorney Docket No.:) Cleveland, OH 44114
MED 2 1115) January 8, 2002

PROPOSED AMENDMENT TO THE DRAWINGS

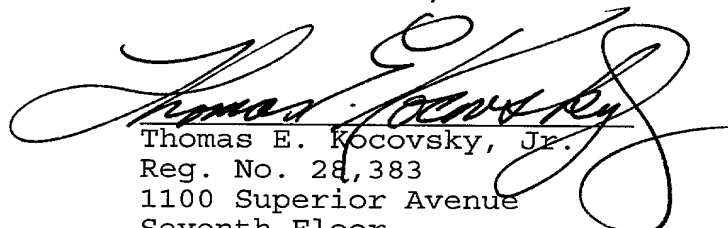
Assistant Commissioner
For Patents
Washington, D.C. 20231

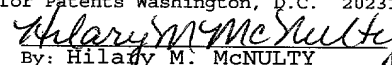
Dear Sir:

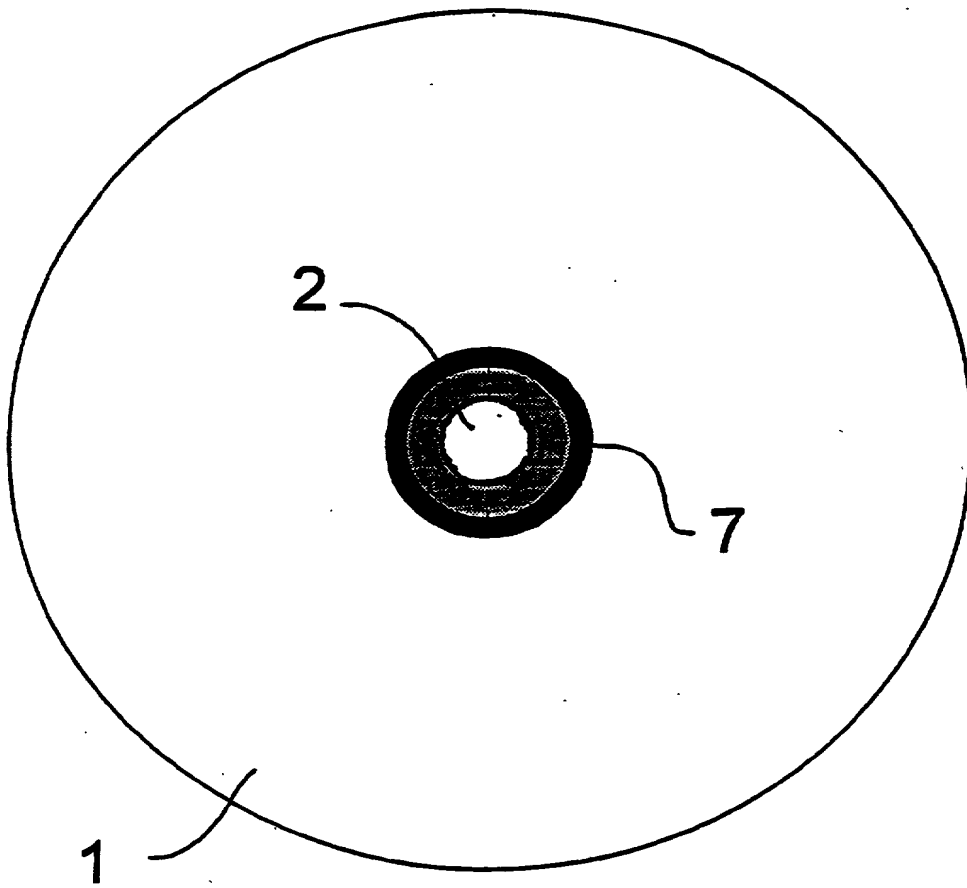
The applicants propose to add the captions
"PRIOR ART" to FIGURES 1 and 2. The applicants take the
liberty of enclosing new Formal Drawings with this
correction made. An early indication of the acceptability
of the Formal Drawings is earnestly solicited.

Respectfully submitted,

FAY, SHARPE, FAGAN,
MINNICH & MCKEE, LLP

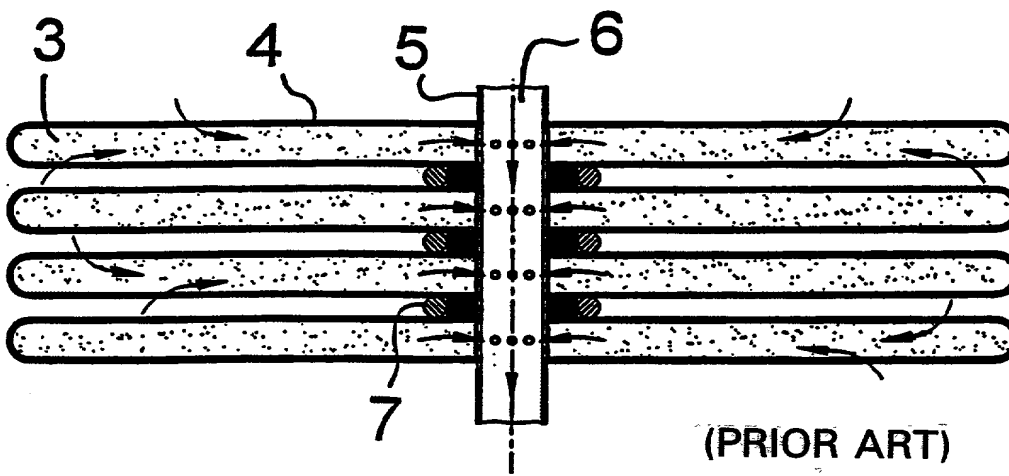

Thomas E. Kocovsky, Jr.
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By: Hilary M. McNULTY



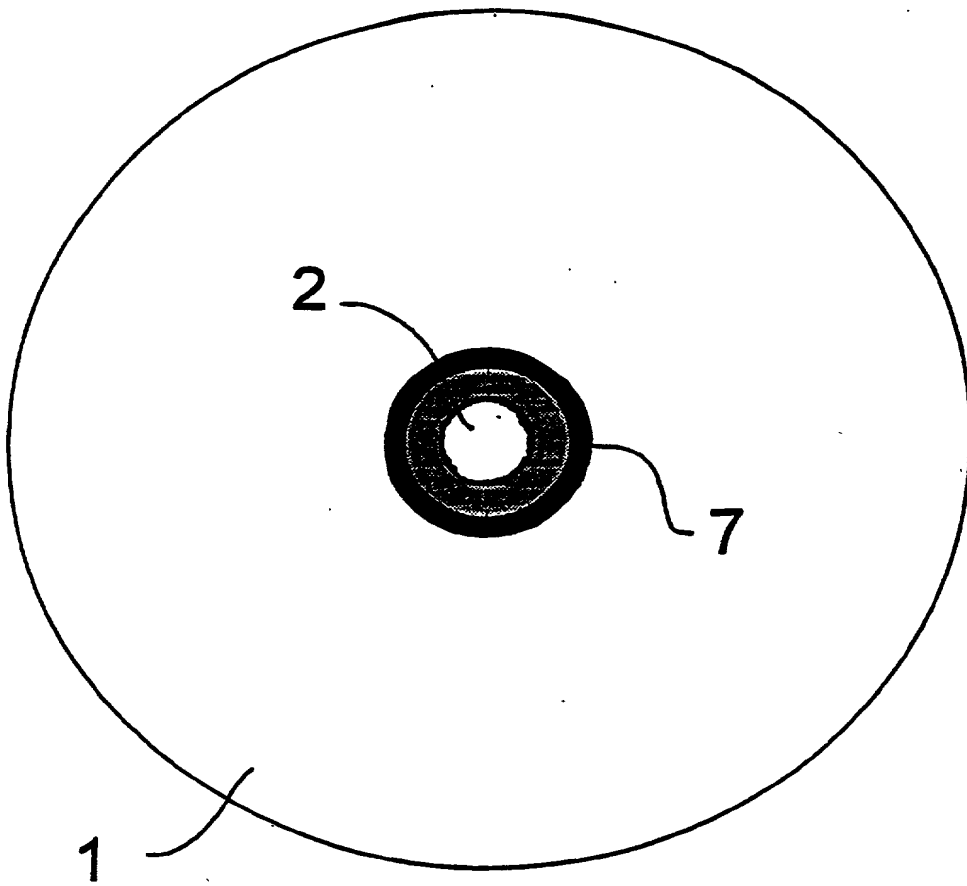
(PRIOR ART)

Fig. 1



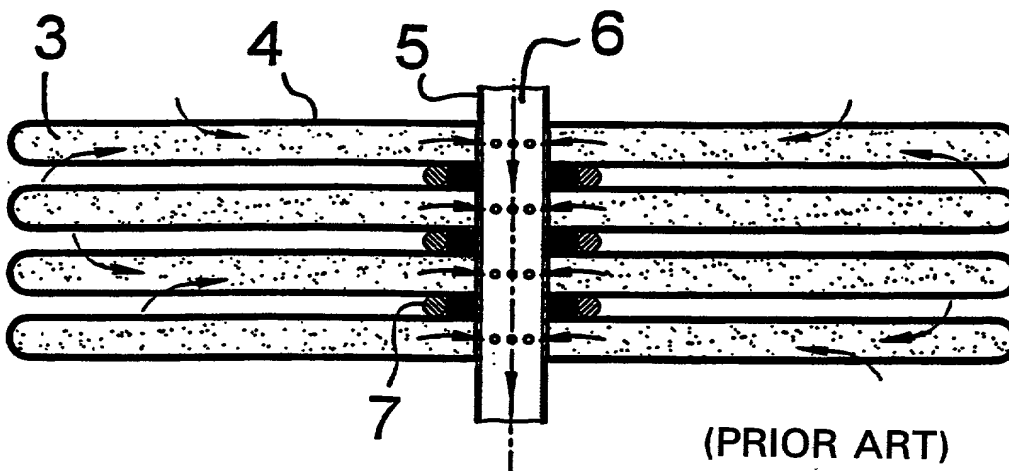
(PRIOR ART)

Fig. 2



(PRIOR ART)

Fig. 1



(PRIOR ART)

Fig. 2

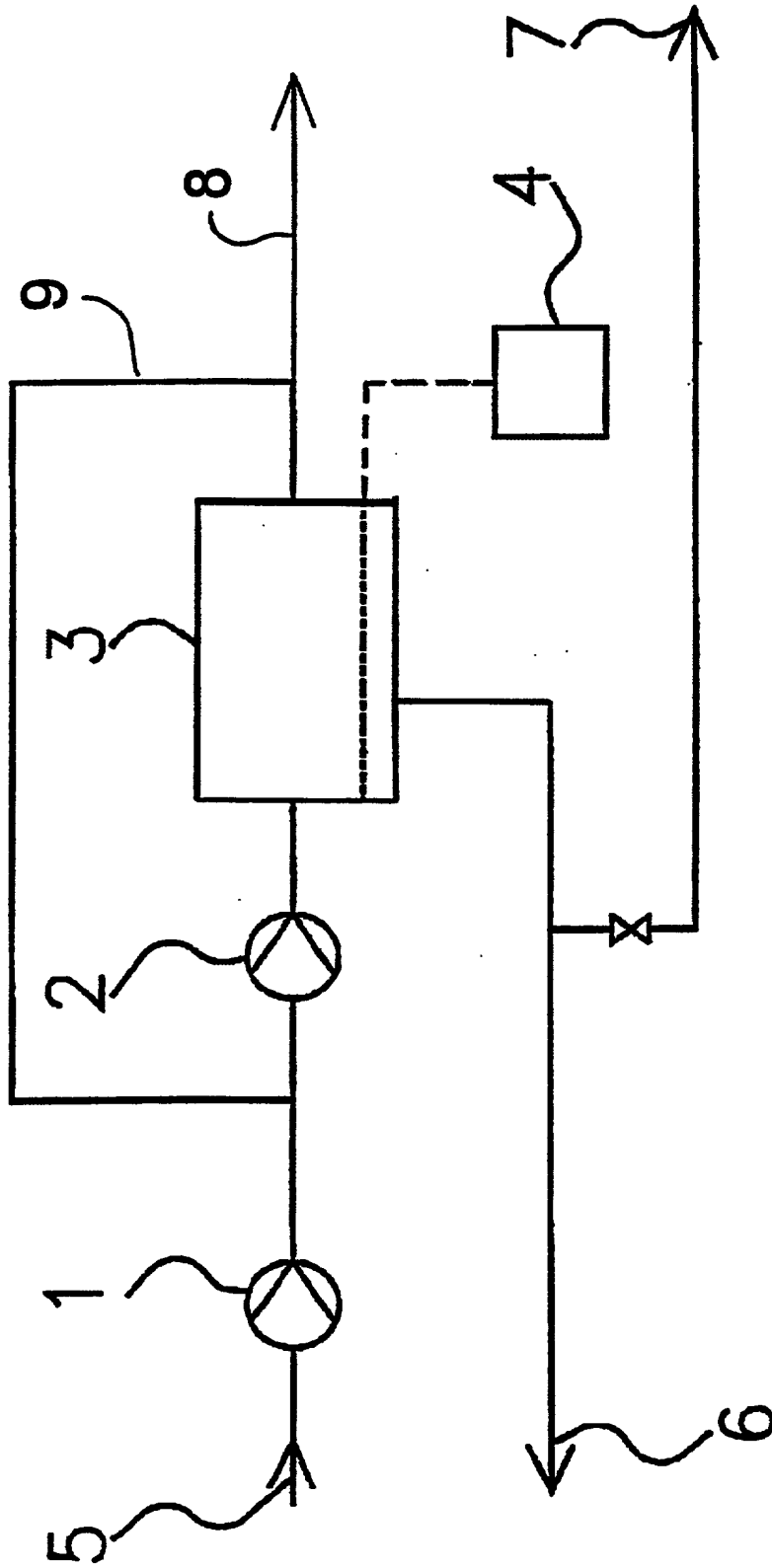


Fig. 3

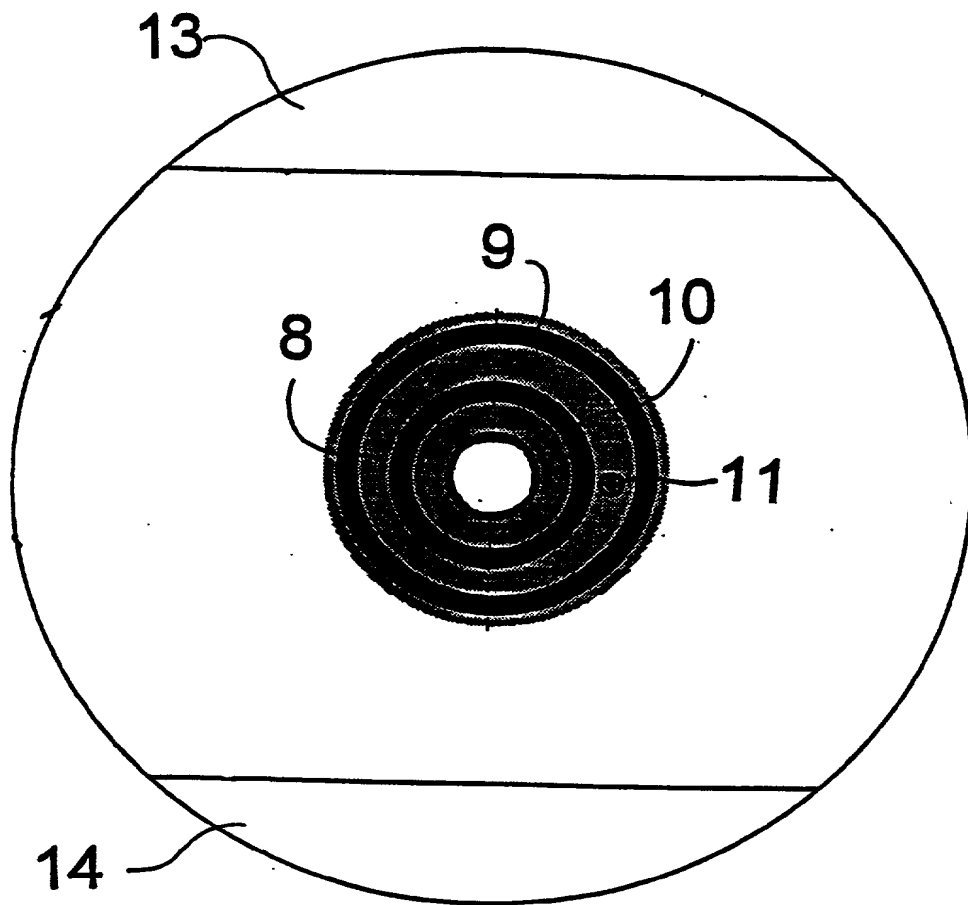


Fig. 4

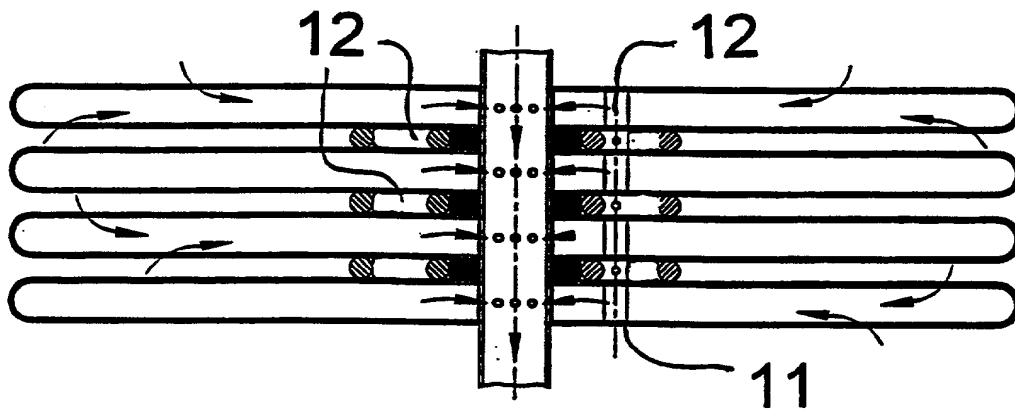


Fig. 5

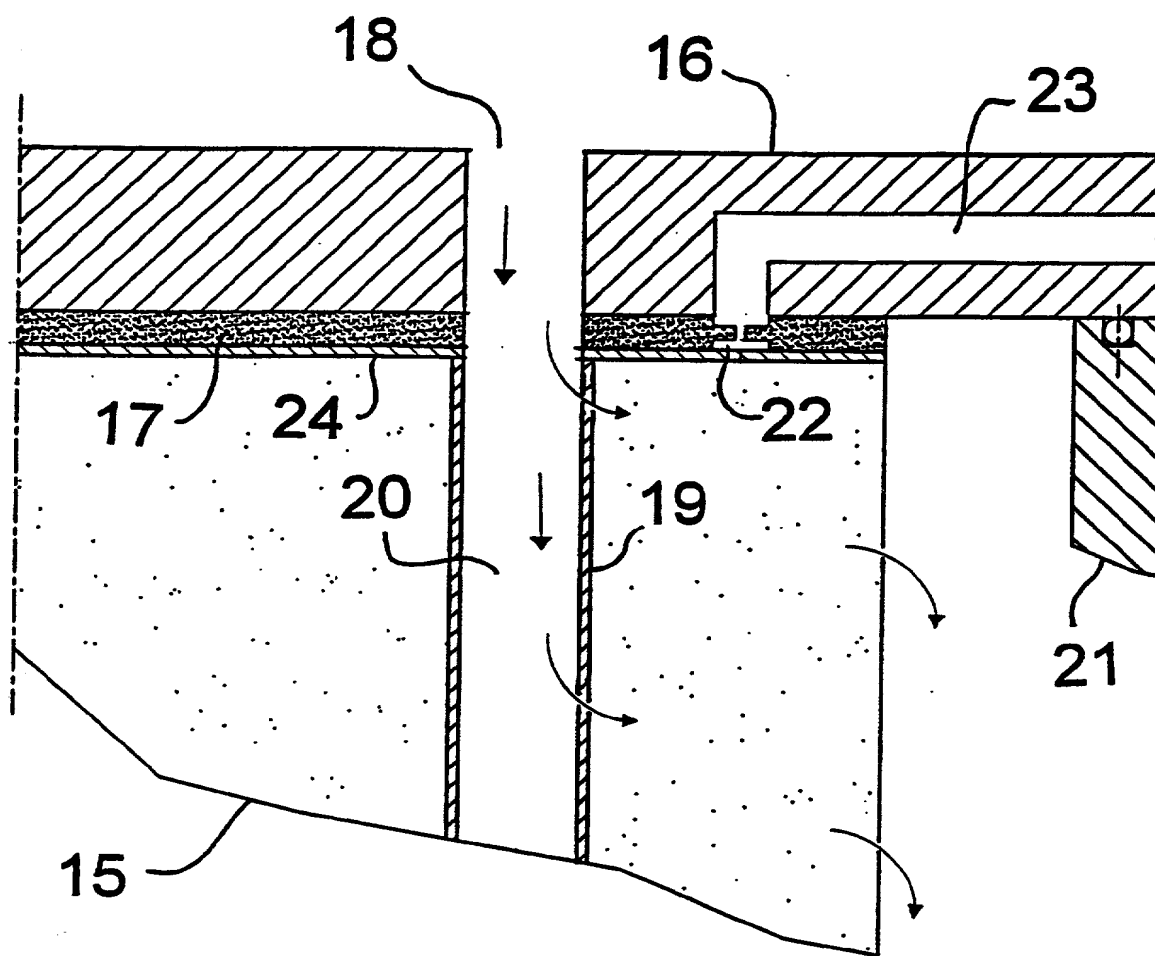


Fig. 6

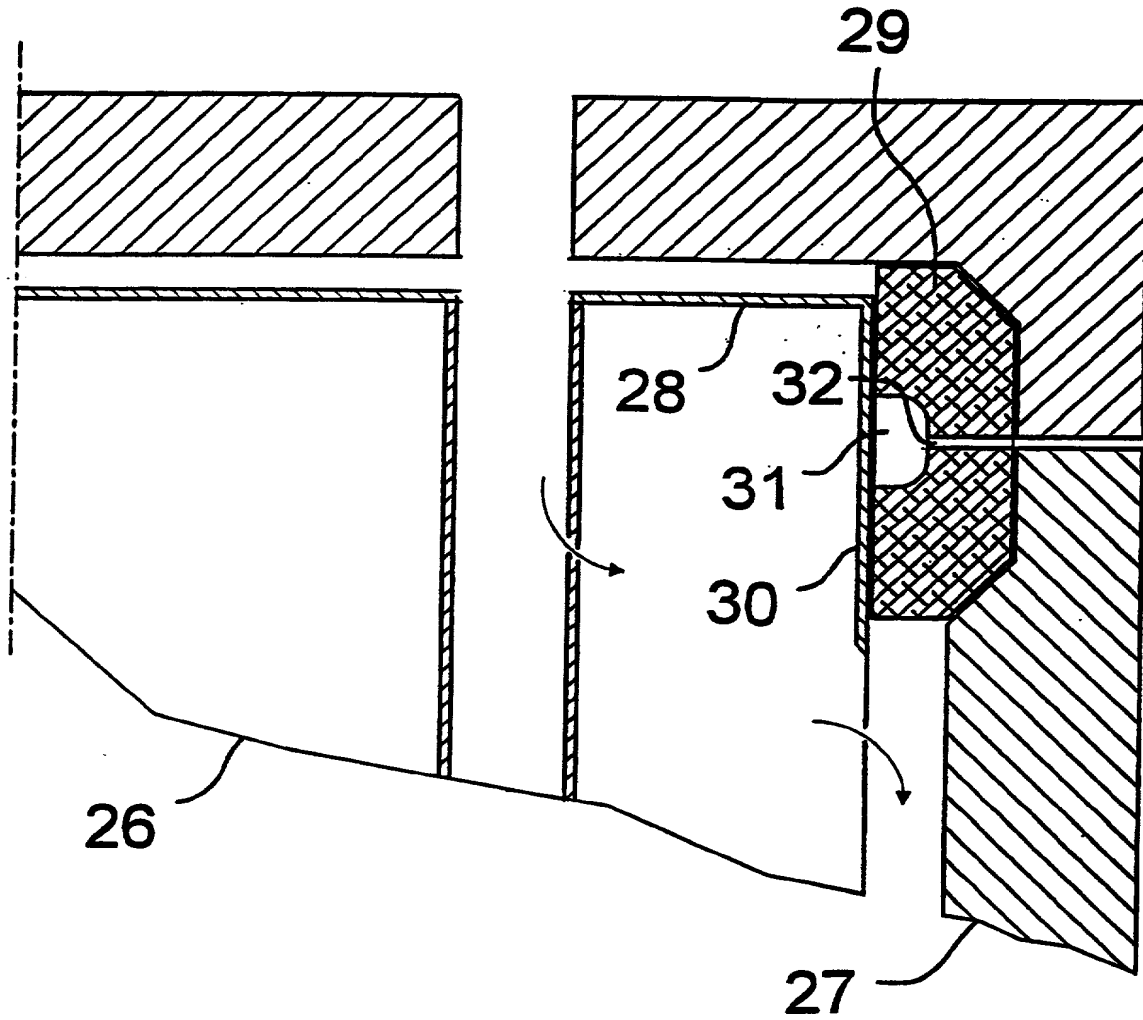


Fig. 7

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:)	Examiner: Unknown
T. NURMINEN, et al.)	
)	Art Unit:
Serial No.: Unknown)	
)	
Filed: Herewith)	
)	
For: FILTERING UNIT AND)	
METHOD OF SEALING SAME)	
)	
Attorney Docket No.:)	Cleveland, OH 44114
MED 2 1115)	January 8, 2002

PRELIMINARY AMENDMENT A

Assistant Commissioner
For Patents
Washington, D.C. 20231

Dear Sir:

In the Abstract:

Please cancel the abstract and replace it with the abstract on the attached sheet.

In the Specification:

Please cancel the paragraph at the bottom of page 2, line 24 to page 3, line 2, and replace it with the following paragraph:

--FIGURE 1 shows a filter plate 1 according to the prior art, having a central bore 2. FIGURE 2 shows a section of part of a stack formed from plates 1. Four plates are shown in the Figure, but the stack may comprise additional plates depending on required filter surface area; the stack is confined in a housing not shown in the Figure. In the housing, a flow of pressurized mixture for filtration is maintained. The plates comprise a porous ceramic support body 3, formed from e.g., aluminum oxide and having a relatively large pore size, e.g., $> 1\mu\text{m}$, and

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Hilary M. McNulty
By: Hilary M. McNULTY

10030738 "041502"

on the surface of the support body has been formed a ceramic filter membrane 4. The membrane has been formed from e.g., titanium or zirconium oxide. The central bores 2 of the plates form a permeate channel 6; in the embodiment shown, a perforated tube 5 is provided therein. The joints between the mating faces of the plates are sealed by means of O-rings 7.--

On page 3, line 19, please cancel the title and substitute the new title:

--Summary of the Invention--.

On page 4, line 29, before the heading "Brief description of the drawings", please insert the paragraph:

--Still further advantages of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.--

On page 4, line 30, after the title "Brief description of the drawings", please insert the paragraph:

--The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating a preferred embodiment and are not to be construed as limiting the invention.--

On page 5, line 12, please delete the heading "Detailed description" and insert the new heading:

--Detailed Description of the Preferred Embodiments--

10030738 "041502"

At the end of page 7, line 4, please insert the paragraph:

--The invention has been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.--

On page 8, after the heading "Claims", please insert:

--Having thus described the preferred embodiment, the invention is now claimed to be:--

In the Claims:

Please amend claims 1-7 as follows:

1. (Amended) A crossflow ceramic membrane filtering unit comprising:

a housing;

5 one or more filtering elements partly coated with a filtering membrane;

joints between the filtering elements and between the filtering elements and the housing being sealed by means of a gasket or a gasket system which defines an internal intermediate space.

2. (Amended) The ceramic membrane filtering unit according to claim 1, wherein the intermediate space is connected to the outside of the filtering unit.

3. (Amended) The ceramic membrane filtering unit according to claim 1 further including:

a sensor for indicating fluid leaking into the intermediate space.

4. (Amended) The ceramic membrane filtering unit according to claim 1 wherein the filtering elements include one or more plate-shaped filtering elements having apertures, said elements being jointed together and to the housing, said apertures thereby forming a tight, unitary conduit for permeate removal and the outer surface of the elements being essentially free to receive material to be filtered, the plate-shaped elements being fitted to each other and to the housing by means of at least two gaskets, and central zones of the elements being impermeable so as to form spaces delimited by the gaskets and the impermeable surfaces, and said spaces being interconnected by apertures in the elements, said apertures having impermeable surfaces.

5. (Amended) The ceramic membrane filtering unit according to claim 1 wherein the filtering elements include at least one tubular filtering element having at least one channel internally coated with a filtering membrane.

6. (Amended) A method for sealing a ceramic crossflow membrane filtering unit comprising one or more filtering elements within a housing, said elements being partly coated with a filtering membrane, the method comprising:

sealing joints between the elements and between the elements and the housing by a gasket or a gasket system comprising an internal space connected to the outside.

7. (Amended) The method according to claim 6 further including:

filtering water.

Please add new claims 8-17 as follows:

8. (New) The method according to claim 7 further including ultrafiltering water.

9. (New) A crossflow membrane filtering unit comprising:

at least one filter element having a feed surface over which a feed liquid flows and a discharge surface from which a permeate flow is discharged;

a seal assembly disposed between the filter element and one of another filter element and a housing, the seal assembly including:

an inner seal in fluid communication with the feed liquid flow,

an outer seal in fluid communication with the permeate flow, and

a channel between the inner and outer seals, the channel in communication with a leakage discharge channel such that liquid discharge through the discharge channel is indicative of leakage through at least one of the inner and outer seals.

10. (New) The crossflow membrane filtering unit according to claim 9 wherein the at least one filter element includes:

a plurality of filter plates, each plate having an aperture defined by the discharge surface, an impermeable surface surrounding the aperture, and the feed surface surrounding the impermeable surface, the plates being stacked with the apertures in alignment and the seal assembly between the impermeable surfaces of adjacent plates.

11. (New) The crossflow membrane filtering unit according to claim 10 wherein the inner and outer seals each include an annular gasket, the inner and outer gaskets being spaced to define the channel.

12. (New) The crossflow membrane filtering unit according to claim 9 wherein the filter element includes:

an interior bore extending between end surfaces,
5 the interior bore being surrounded by the inflow surface;
the end surfaces being impermeable, the seal assembly being disposed between at least one end surface and a housing in which the filtering element is received.

13. (New) The crossflow membrane filtering unit according to claim 9 wherein the filter element includes:

an interior bore defined by the inflow surface;
5 a peripheral surface having an impermeable ring at least at one end and the permeate surface defined thereadjacent;
the seal assembly between being disposed between the impermeable ring and a housing in which the filter
10 element is received.

14. (New) The crossflow membrane filtering unit according to claim 9 further including:

a sensor disposed in communication with the channel for sensing a presence of liquid in the channel.

15. (New) A method of ceramic membrane filtering comprising:

flowing a feed liquid over a feed surface of a filter element and discharging a permeate liquid from a
5 discharge surface of the filter element, the feed liquid and the permeate liquid being separated from each other by a seal assembly disposed between the filter element and at

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least one of another filter element and a housing in which the filter element is received, the seal assembly having a first seal in communication with the feed liquid and a second seal in communication with the permeate liquid and a channel therebetween;
10 monitoring the channel for the presence of liquid.

16. (New) The method according to claim 15 further including:

in response to detecting liquid in the channel, determining whether the liquid is the feed liquid or the permeate liquid.
5

17. (New) The method according to claim 15 wherein the feed liquid is heat sterilized water.

A copy of the pending claims, including a marked-up copy of claims 1-7 showing the modifications is attached as APPENDIX 1.

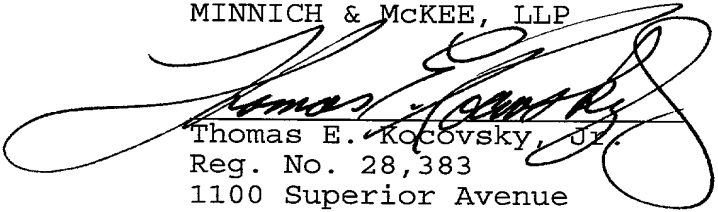
REMARKS

This amendment is to eliminate multiple dependent claims and place the application in better form for examination and an early allowance.

An early examination and allowance of all claims is earnestly solicited.

Respectfully submitted,

FAY, SHARPE, FAGAN,
MINNICH & MCKEE, LLP



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205TH08E2000T

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:)	Examiner: Unknown
T. NURMINEN, et al.)	
)	Art Unit:
Serial No.: Unknown)	
)	
Filed: Herewith)	
)	
For: FILTERING UNIT AND)	
METHOD OF SEALING SAME)	
)	
Attorney Docket No.:)	Cleveland, OH 44114
MED 2 1115)	January 8, 2002

APPENDIX 1

In the Specification:

Marked-up copies of paragraphs amended in specification:

page 2, lines 24 - page 3, line 2:

--FIGURE 1 shows a filter plate 1 according to the prior art, having a central bore 2. FIGURE 2 shows a section of part of a stack formed from plates 1. [Three] Four plates are shown in the Figure, but the stack may comprise additional plates depending on required filter surface area; the stack is confined in a housing not shown in the Figure. In the housing, a flow of pressurized mixture for filtration is maintained. The plates comprise a porous ceramic support body 3, formed from e.g., aluminum oxide and having a relatively large pore size, e.g., $> 1\mu\text{m}$, and on the surface of the support body has been formed a ceramic filter membrane 4. The membrane has been formed from e.g., titanium or zirconium oxide. The central bores 2 of the plates form a permeate channel 6; in the embodiment shown, a perforated tube 5 is provided therein. The joints between the mating faces of the plates are sealed by means of O-rings 7.--

On page 3, line 19, please cancel the title and substitute the new title:

--Summary of the Invention--.

On page 4, line 29, before the heading "Brief description of the drawings", please insert the paragraph:

Still further advantages of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

On page 4, line 30, after the title "Brief description of the drawings", please insert the paragraph:

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating a preferred embodiment and are not to be construed as limiting the invention.

On page 5, line 12, please delete the heading "Detailed description" and insert the new heading:

--Detailed Description of the Preferred Embodiments--

At the end of page 7, line 4, please insert the paragraph:

The invention has been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come

within the scope of the appended claims or the equivalents thereof.

On page 8, after the heading "Claims", please insert:

Having thus described the preferred embodiment, the invention is now claimed to be:

In the Claims:

Copy of Pending claims - with markings showing amendments made

Please amend claims 1-7 as follows:

1. (Amended) A crossflow [Crossflow] ceramic membrane filtering unit [having within] comprising:

a housing;

5 one or more filtering elements partly coated with a filtering membrane[, characterized by the];

joints between the filtering elements and between the filtering elements and the housing being sealed by means of a gasket or a gasket system [comprising] which defines an internal intermediate space.

2. (Amended) The ceramic membrane [Membrane] filtering unit according to claim 1, [characterized by] wherein the intermediate space [being] is connected to the outside of the filtering unit.

3. (Amended) The ceramic membrane [Membrane] filtering unit according to claim 1 [or 2, characterized by having] further including:

5 a sensor for indicating fluid leaking into the intermediate space.

4. (Amended) The ceramic [Ceramic] membrane filtering unit according to [any] claim 1[-3, comprising] wherein the filtering elements include one or more plate-shaped filtering elements having apertures, said elements
5 being jointed together and to the housing, said apertures thereby forming a tight, unitary conduit for permeate removal and the outer surface of the elements being essentially free to receive material to be filtered, [characterized by] the plate-shaped elements being fitted
10 to each other and to the housing by means of at least two gaskets, and [the] central zones of the elements being impermeable so as to form spaces delimited by the gaskets and the impermeable surfaces, and said spaces being interconnected by apertures in the elements, said
15 apertures having impermeable surfaces.

5. (Amended) The ceramic [Ceramic] membrane filtering unit according to [any] claim 1[-3, comprising] wherein the filtering elements include at least one tubular filtering element having at least one channel
5 internally coated with a filtering membrane.

6. (Amended) A method [Method] for sealing a ceramic crossflow membrane filtering unit comprising one or more filtering elements within a housing, said elements being partly coated with a filtering membrane,
5 [characterized by] the method comprising:

sealing [the] joints between the elements and between the elements and the housing by a gasket or a gasket system comprising an internal space connected to the outside.

7. (Amended) The [use of a filtering unit according to claim 1 or a] method according to claim 6 [in the] further including:

5 [filtration, preferably ultrafiltration, of] filtering water.

Please add new claims 8-17 as follows:

8. (New) The method according to claim 7 further including ultrafiltering water.

9. (New) A crossflow membrane filtering unit comprising:

5 at least one filter element having a feed surface over which a feed liquid flows and a discharge surface from which a permeate flow is discharged;

a seal assembly disposed between the filter element and one of another filter element and a housing, the seal assembly including:

10 an inner seal in fluid communication with the feed liquid flow,

an outer seal in fluid communication with the permeate flow, and

15 a channel between the inner and outer seals, the channel in communication with a leakage discharge channel such that liquid discharge through the discharge channel is indicative of leakage through at least one of the inner and outer seals.

10. (New) The crossflow membrane filtering unit according to claim 9 wherein the at least one filter element includes:

5 a plurality of filter plates, each plate having an aperture defined by the discharge surface, an impermeable surface surrounding the aperture, and the feed

surface surrounding the impermeable surface, the plates being stacked with the apertures in alignment and the seal assembly between the impermeable surfaces of adjacent plates.

11. (New) The crossflow membrane filtering unit according to claim 10 wherein the inner and outer seals each include an annular gasket, the inner and outer gaskets being spaced to define the channel.

12. (New) The crossflow membrane filtering unit according to claim 9 wherein the filter element includes:

an interior bore extending between end surfaces, the interior bore being surrounded by the inflow surface; the end surfaces being impermeable, the seal assembly being disposed between at least one end surface and a housing in which the filtering element is received.

13. (New) The crossflow membrane filtering unit according to claim 9 wherein the filter element includes:

an interior bore defined by the inflow surface; a peripheral surface having an impermeable ring at least at one end and the permeate surface defined thereadjacent;

the seal assembly between being disposed between the impermeable ring and a housing in which the filter element is received.

14. (New) The crossflow membrane filtering unit according to claim 9 further including:

a sensor disposed in communication with the channel for sensing a presence of liquid in the channel.

15. (New) A method of ceramic membrane filtering comprising:

5 flowing a feed liquid over a feed surface of a filter element and discharging a permeate liquid from a discharge surface of the filter element, the feed liquid and the permeate liquid being separated from each other by a seal assembly disposed between the filter element and at least one of another filter element and a housing in which the filter element is received, the seal assembly having
10 a first seal in communication with the feed liquid and a second seal in communication with the permeate liquid and a channel therebetween;

monitoring the channel for the presence of liquid.

16. (New) The method according to claim 15 further including:

5 in response to detecting liquid in the channel, determining whether the liquid is the feed liquid or the permeate liquid.

17. (New) The method according to claim 15 wherein the feed liquid is heat sterilized water.

FILTERING UNIT AND METHOD OF SEALING SAME

Abstract of the Disclosure

Ceramic filter elements (1, 15, 26) have a feed surface covered with a ceramic filter membrane (4, 19). As a feed liquid flows over the feed surface, a portion of the liquid passes through the membrane and the filter and is discharged through a discharge surface as a permeate liquid flow. Between the feed and discharge surfaces, the filter element includes an impermeable surface portion (8, 24, 30) which contacts a seal or gasket assembly (17, 29). The seal or gasket assembly includes two seal portions (9, 10) which define a channel (12, 22, 31) in between. The channel connects with a discharge channel (11, 23, 32). In this manner, any liquid leaking between the filter element and another filter element or a housing (21, 27) enters the discharge channel (11, 23, 32). Liquid in the discharge channel indicates a leak in the seal and potential contamination of the permeate liquid.

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PCT/FI00/00556

FILTERING UNIT AND METHOD OF SEALING SAME

Field of the inventionField of the inventionField of the invention

The invention relates to filtration by means of crossflow technique and filtering elements having a filter membrane on a porous carrier.

Particularly, the invention relates to a crossflow membrane filtering unit having a sealing system including a channel enabling the detection of a leak without the quality of the filtrate being impaired.

Background of the inventionBackground of the inventionBackground of the invention

The removal of solids from a liquid by filtration can take place in several, principally different manners. In so-called dead end filtration, a suspension is driven in its entirety towards a filter, and a filter cake is formed which the filtrate penetrates. In cross-flow filtration, the mixture to be filtered is pumped across the filter element in a circuit, whereby part of the mixture penetrates the filtering elements forming a permeate stream. In the ideal case, no cake is formed, but the material to be separated is enriched in the circulating phase, and a certain fraction is continuously being removed therefrom as a reject stream. The quality of the permeate is basically dependant on the pore size of the filtering element membrane. This pore size can be very narrowly defined. In microfiltration, the pore diameter can be 0.1 - 10 µm, and in ultrafiltration down to 1 nm. Thus, separation of molecules on the basis of size is possible by means of filtration. One application is the removal of pyrogens from water, pyrogens having relatively large molecules.

Membrane filtration elements have porous carrier structures, on the filtering surfaces of which membranes having well defined pore sizes have been formed.

Membranes with small pore sizes can be formed from e.g. polymer films. These are not, however, particularly resistant to mechanical and thermal stress, which is a drawback in sterilisation and cleaning. Ceramic membranes on porous, ceramic carrier phases have also been developed. Most ceramic materials resist heat in addition to being mechanically durable. On a ceramic element, as on other materials, surfaces can also be sealed, i.e. made impermeable. Thus, three types of surfaces may occur on a ceramic filter element: membrane coated, sealed, and untreated, through which permeate flows freely.

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For example, in US patent 5,104,546 a multilayer ceramic tubular filter element is disclosed, suitable for pyrogen removal by ultrafiltration. The end walls of the element as well as the inner walls of the channels are membrane coated. When the element is fitted into a shell or housing, and a mixture is pumped through the inner channels, permeate
5 flows through the porous carrier to the shell side. Seals, for example rubber gaskets, must be provided between the shell and the element end walls.

In addition to tubular elements, plate-shaped ceramic elements are generally known, see for example WO 98/28060 and references therein. A plate-shaped filter element has a
10 membrane coated outer surface and an aperture in the centre or elsewhere, the walls of which aperture are not membrane coated. Filters can be assembled by stacking such plates, as shown in e.g. GB 1 268 875. Due to the shape of the plates, the mating surfaces may be higher than the filter surfaces, whereby free filter area is provided between the plates as stacks are formed; plates may be separated by spacers; or if the seals between plates are
15 thick enough, the seals function as spacers. Thus, the central apertures form a permeate retrieval and exit channel, and the plate stack forms a flanged-tube structure across which the pressurised mixture to be filtered is allowed to flow. The mixture thus flows on the shell side and the permeate is collected from the inner channel.

20 As stacks are assembled, seals must be used between the plates and/or the spacers, and between the elements and the housing, the number of seals being proportional to the number of plates used.

Figure 1 shows a ceramic filter plate 1 according to the prior art, having a central bore 2.

25 Figure 2 shows a section of part of a stack formed from plates 1. Three plates are shown in the figure, but the stack may comprise additional plates depending on required filter surface area; the stack is confined in a housing not shown in the figure. In the housing, a flow of pressurised mixture for filtration is maintained. The plates comprise a porous ceramic support body 3, formed from e.g. aluminium oxide and having a relatively large pore size,
30 e.g. $> 1 \mu\text{m}$, and on the surface of the support body has been formed a ceramic filter membrane 4. The membrane has been formed from e.g. titanium or zirconium oxide. The central bores 2 of the plates form a permeate channel 6; in the embodiment shown, a perfo-

rated tube 5 is provided therein. The joints between the mating faces of the plates are sealed by means of O-rings 7.

During the filtration process, bodies smaller than the pores of membrane 4, as e.g. water molecules in the case of ultrafiltration, pass through the membrane due to the pressure difference, and are carried through the porous support body into the permeate chamber and exit through the end fittings.

In the above described filter units, the seals between the mixture and the permeate side are potential leak sites, and in demanding filtering processes a small leak may immediately render the permeate useless, as the mixture to be filtered penetrates into the permeate channel.

In tube or tube bundle type ceramic filter units, the sealing problem is associated with the end sections of the units. If the feed mixture penetrates the joint between the housing and the filter element and enters the shell side, the permeate is contaminated. In plate stack-type filter units, potential leak sites are the joints between the plates and between the plate stack and the housing.

Disclosure of the invention

A main object of the invention is a crossflow-type membrane filtering unit according to claim 1, wherein the sealing system between the filtering element and its housing comprises a channel through which the feed mixture on penetrating the seal system can flow without penetrating the whole sealing system, thereby indicating a leak.

In an embodiment using plate-shaped filtering elements, two concentric seals are preferably used between the filter plates. Thus, a space delimited by the seals and two plates is formed. At the location of said space, the plate surface is sealed, that is made impermeable. In addition, at the location of said space, at least one opening is provided in each plate, interconnecting the spaces between adjacent plates in the stack. The walls of the opening(s) are also sealed, and consequently an isolated, sealed space surrounding the permeate channel is formed. A tube or equivalent can be provided to connect this space to the outside. If a leak occurs in a seal between two plates, the fluid may thus flow into the

isolated space and out. Thus, a leaking seal can be detected immediately, and no possibility exists for the feed mixture to enter the permeate channel.

Preferably, the double seal system consists of two concentric, annular seals of different diameter. The seals may be of the O-ring type, and corresponding grooves may be provided in the filter plates. A huge range of O-ring seals designed for various chemical and physical conditions is available, and as the chemical and thermal durability of ceramic filter plates is usually high, a filter structure is thus provided which is functional in harsh conditions, with a low risk for permeate contamination by feed mixture.

In embodiments comprising filter elements of a tube or tube bundle structure, the joint between the filter housing and the filter element must be reliably sealed. The seal can be formed between the element end wall and the housing, or between the side walls of the element and the housing, and appropriate surface sealing of the filter element at the site of the seal system must be provided.

Surface sealing can be effected in various manners known to the person skilled in the art. On ceramic filter elements the surface may be glazed, or organic coatings may be used according to the process requirements. Organic coatings are obviously useful in the case of organic filtering elements. Metal foils is another possibility.

A further object of the invention is to provide a method of sealing a crossflow membrane filtering unit comprising one or more filtering elements within a housing, according to claim 6.

Preferably, filtering units according to the invention are used in water filtration, more preferably water ultrafiltration; most preferably filtering units according to the invention are used in the production of heat sterilised, pyrogen-free water.

Brief description of the drawings

Figure 1 shows a ceramic filter plate according to the prior art; figure 2 shows a sideways section of a plate stack according to the prior art, assembled from plates according to claim 1;

figure 3 is a schematic overview of a crossflow filtration system;

figure 4 shows a ceramic filter plate according to the present invention;

figure 5 shows a sideways section of a plate stack according to the present invention, assembled from plates according to claim 4;

5 figure 6 shows an embodiment of the present invention, wherein a tubular type filter element is used and the seal is located between the end wall of the element and the head of the housing;

figure 7 shows an embodiment of the present invention, wherein a tubular type filter element is used and the seal is located between the side walls of the element and the housing.

Detailed descriptionDetailed descriptionDetailed description

The invention is described below with reference to the enclosed drawings.

15 In Figure 3, an overview of crossflow filtering system is shown. Material to be filtered enters through the feed line 5, by means of pump 1. Pump 2 serves the filtration circuit, in which the mixture is pumped across filter unit 3. Filter unit 3 can be of any suitable type, e.g. the plate stack type or the tube or tube bundle type mentioned above. Part of the circulating fluid penetrates the pores of the filtering elements, forming the permeate, which leaves through line 6 or alternatively through reject line 7. To keep the concentration of
20 retained material in the filtration circuit at a desired level, a retentate stream is withdrawn through line 8, while the balance remains in the filtration circuit 9.

Figure 4 shows a filter plate according to the invention in a view corresponding to that of the prior art plate shown in Figure 1. In the central zone of the plate, a sealed-surface area 8 has been formed. In this area, two concentric O-ring seals 9, 10 of different diameters have
25 been fitted, and in addition an opening 11 with sealed surfaces has been formed. Figure 5 shows a section analogous to fig. 2. Through openings 11, an essentially pressureless unitary space 12 is formed, surrounding the permeate channel and limited by the seal surfaces and sealed surface areas of the plates. The space 12 communicates with the
30 outside. Permeate that has penetrated the membrane into the porous carrier body cannot penetrate the sealed surface into space 12, but can only enter the permeate channel, as the walls of the central bores are not sealed. If a leak occurs in seal 9, the liquid leaking

through flows into space 12 and out, indicating the presence of a leak. As the pressure in the permeate channel is also greater than in space 12, also leaks occurring in the inner seals 10 are revealed, but the feed mixture is fully prevented from entering the permeate channel. Space 12 is connected to the outside e.g. via a tube through the filter housing.

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The plates shown are circular, but other shapes may be used. For example, segments 13, 14 may be cut off as shown in Figures 1 and 5.

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Figure 6 shows a partial section through the end of another type of filter unit, along a plane parallel to the filtration circuit flow. This unit comprises a tubular filter element 15, a housing head 16 and a seal 17 between these. The end wall of the filter element is sealed by the impermeable layer 24. The feed mixture enters at connection 18 and flows under pressure through the inner channels 20 of the element 15, coated with membrane 19. The permeate flows through the membrane and the porous body 25 of element 15 into the shell space formed by housing wall 21. According to the invention, seal 17 comprises an internal leak detection channel system 22, formed by grooves in the upper and lower surfaces of seal 17, said grooves being interconnected by evenly spaced openings. The channel system 22 communicates with the outside by channel 23, formed in housing head 16. As the feed mixture penetrates the inner part of the filter from the pressure side (18,20) of seal 17, it flows into channel 22 and out via channel 23, indicating the presence of a leak, regardless of whether the leak flow occurs along the upper or the lower face of the seal. The permeate side being normally under a higher pressure than the surroundings, permeate-side seal failures are likewise revealed when the leaking fluid seeps out of channel 23.

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In the embodiment of Figure 7, seal 29 is provided between the end wall of tubular filter element 26 and the housing wall 27. The end surface 28 of the filter element and the wall surface section 30 at the site of filter element are impermeably sealed. On the inner face of seal 29 are provided groove 31 and at least one exit channel 32 connected to the outside, providing a leak indicating channel system in the same manner as illustrated in Figure 6.

30

Possible leaks lead to flows from the joint between the housing head and the housing wall.

Automatic detection of leak flow may be provided in addition to or instead of visual observation. For example, moisture sensors may be provided in the intermediate spaces 12, 22, 31 or their corresponding exit channels, as shown schematically as 4 in Figure 3.

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Claims

1. Crossflow ceramic membrane filtering unit having within a housing one or more filtering elements partly coated with a filtering membrane, **characterised** by the joints
5 between the filtering elements and between the filtering elements and the housing being sealed by means of a gasket or a gasket system comprising an internal intermediate space.

2. Membrane filtering unit according to claim 1, **characterised** by the intermediate space being connected to the outside of the filtering unit.

3. Membrane filtering unit according to claim 1 or 2, **characterised** by having a sensor indicating fluid leaking into the intermediate space.

4. Ceramic membrane filtering unit according to any claim 1-3, comprising one or more
15 plate-shaped filtering elements having apertures, said elements being joined together and to the housing, said apertures thereby forming a tight, unitary conduit for permeate removal and the outer surface of the elements being essentially free to receive material to be filtered, **characterised** by the plate-shaped elements being fitted to each other and to the housing by means of at least two gaskets, and the central zones of the elements being
20 impermeable so as to form spaces delimited by the gaskets and the impermeable surfaces, and said spaces being interconnected by apertures in the elements, said apertures having impermeable surfaces.

5. Ceramic membrane filtering unit according to any claim 1-3, comprising at least one
25 tubular filtering element having at least one channel internally coated with a filtering membrane.

6. Method for sealing a ceramic crossflow membrane filtering unit comprising one or more filtering elements within a housing, said elements being partly coated with a filtering
30 membrane, **characterised** by sealing the joints between the elements and between the elements and the housing by a gasket or a gasket system comprising an internal space connected to the outside.

7. The use of a filtering unit according to claim 1 or a method according to claim 8 in the filtration, preferably ultrafiltration, of water.

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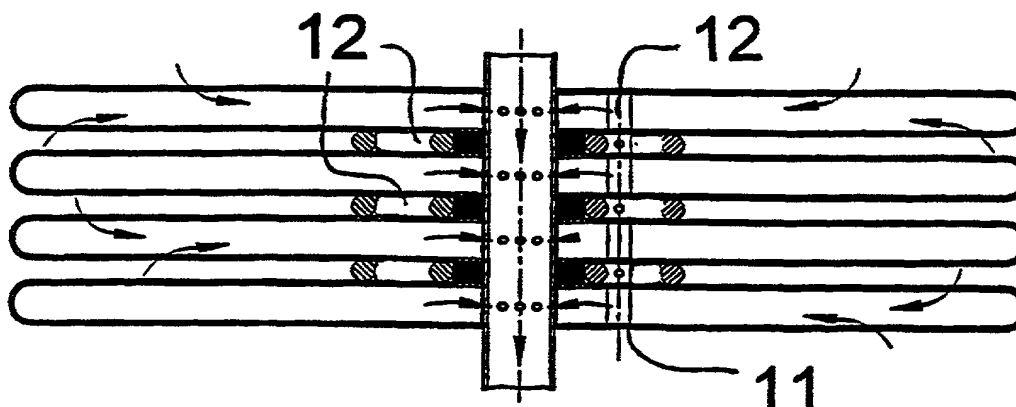
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(54) Title: FILTERING UNIT AND METHOD OF SEALING SAME



(57) Abstract: A crossflow filter comprising at least one membrane coated filtering units in a filter housing. The joints between the housing and the filtering unit are sealed by means of a gasket or a gasket system comprising an intermediate space. As the intermediate space is connected to the outside, a seal leak can be observed from emerging liquid. Thus, a substrate to be filtered cannot penetrate to the filtrate side as a consequence of a seal failure.

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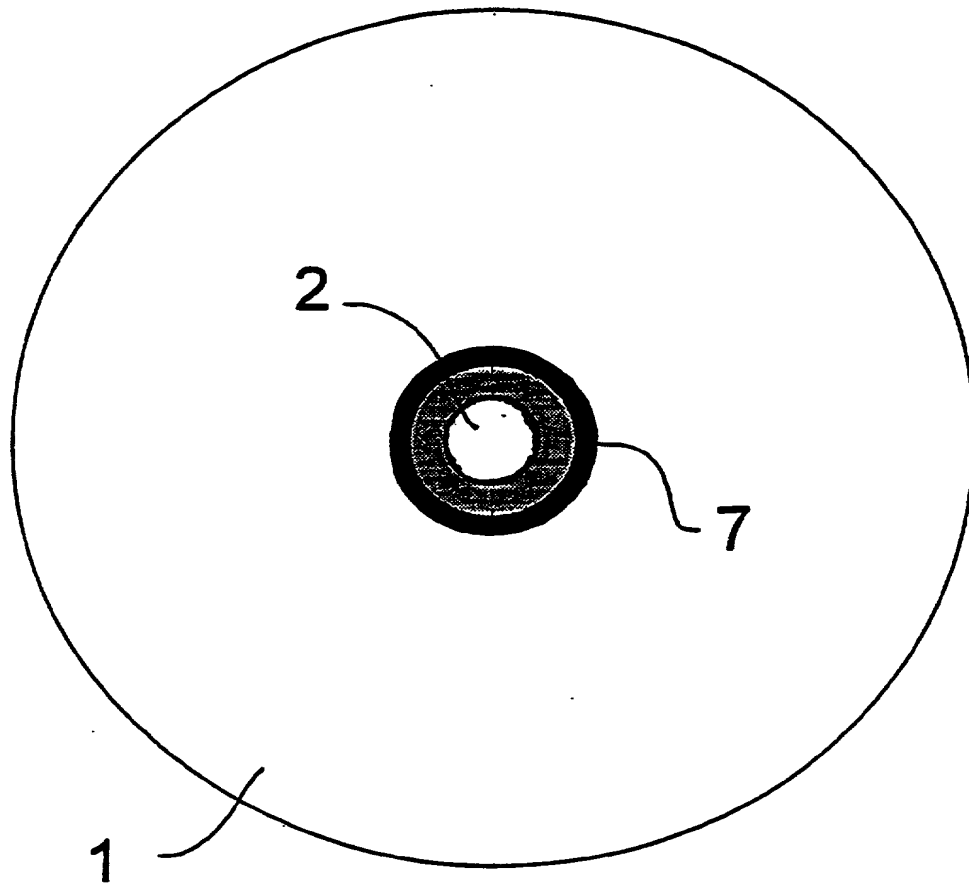


Fig. 1

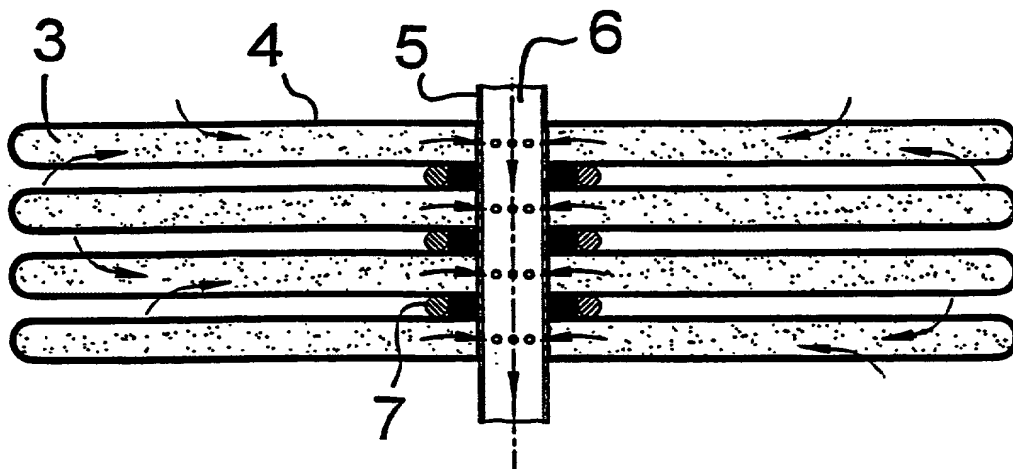


Fig. 2

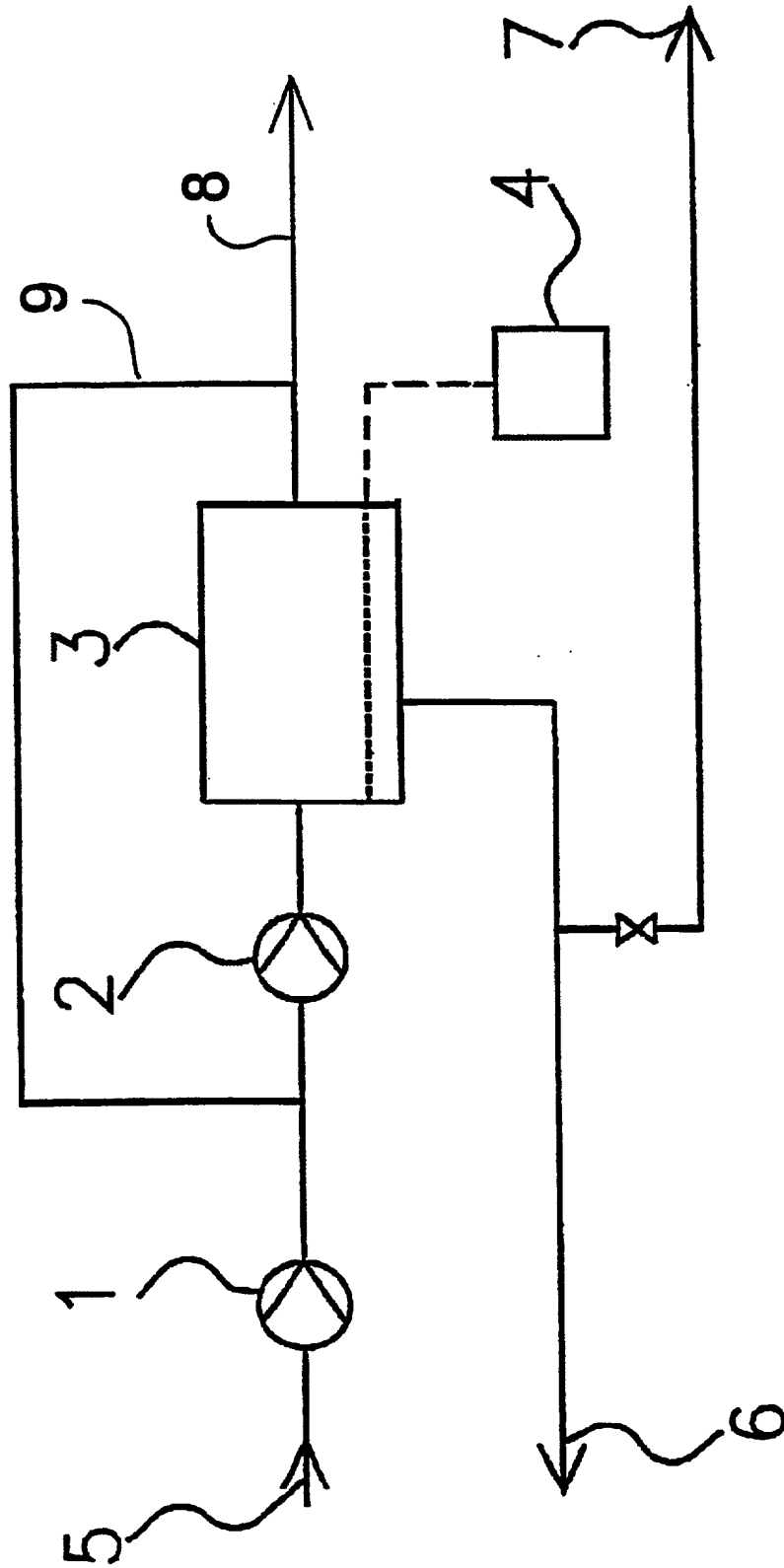


Fig. 3

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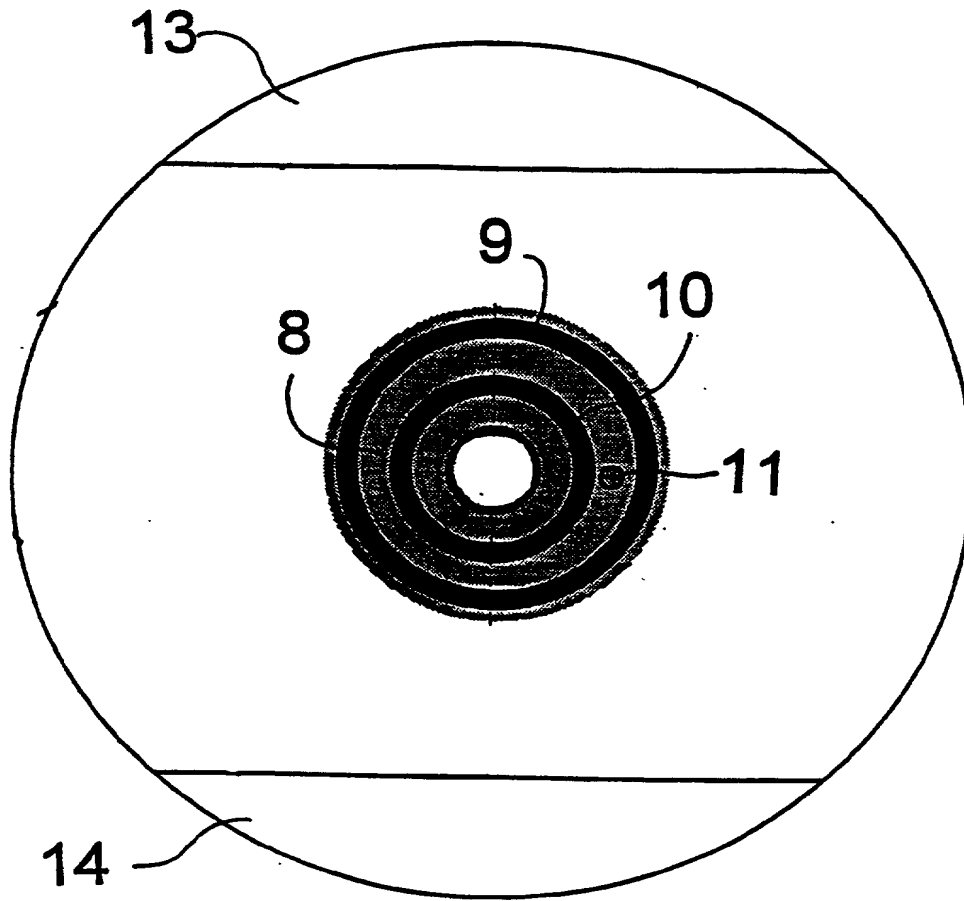


Fig. 4

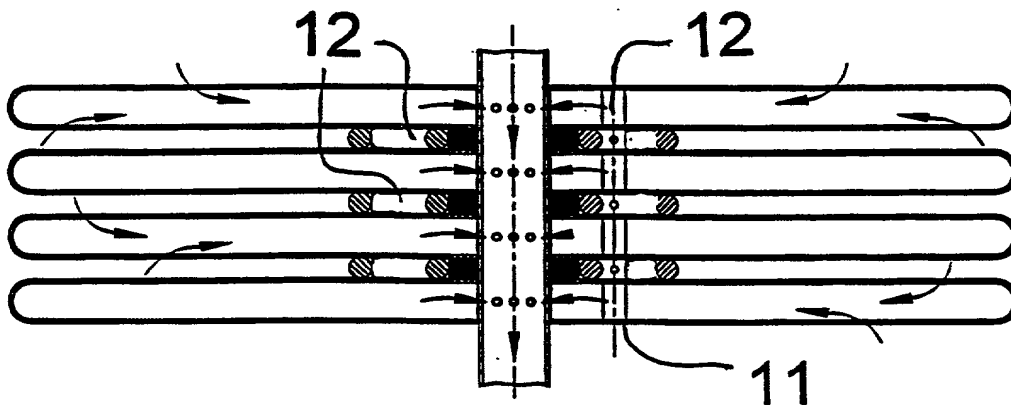


Fig. 5

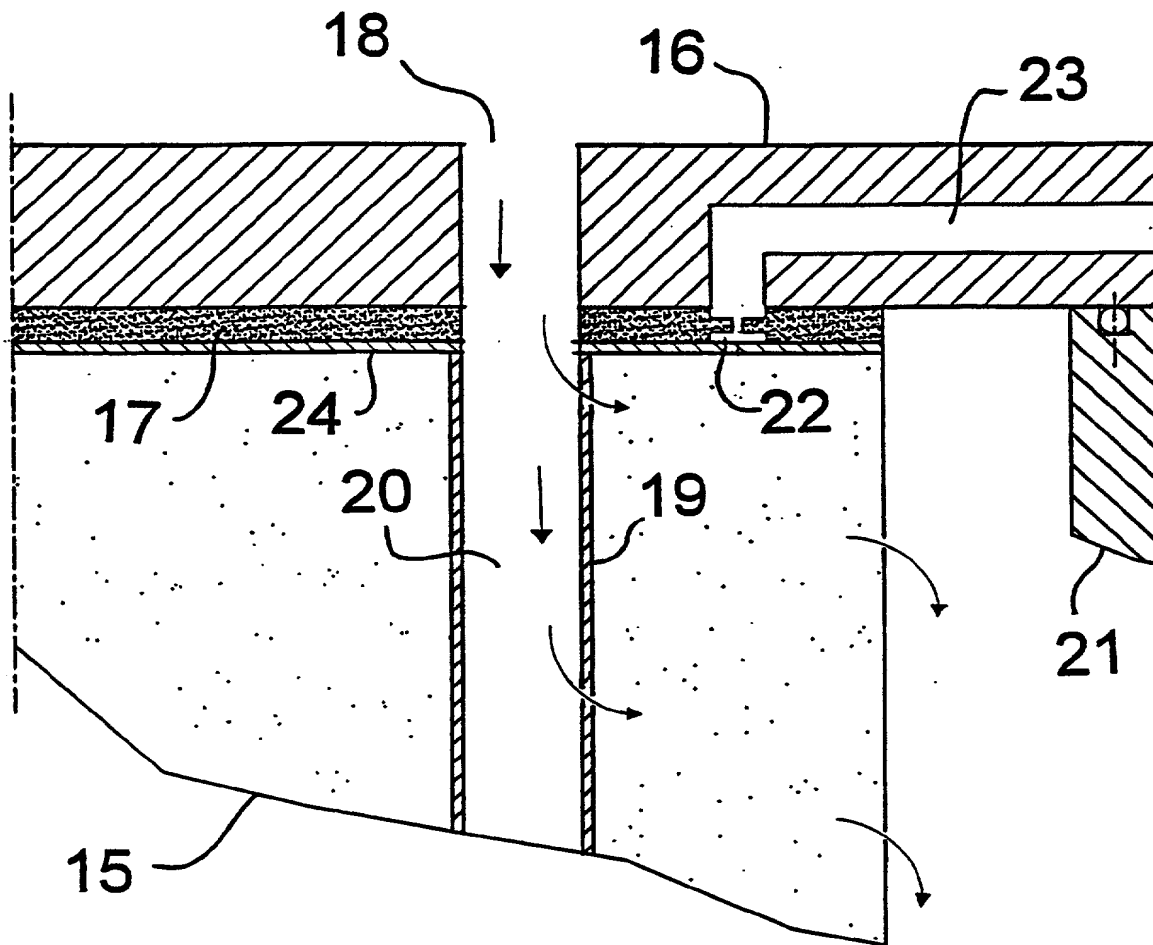


Fig. 6

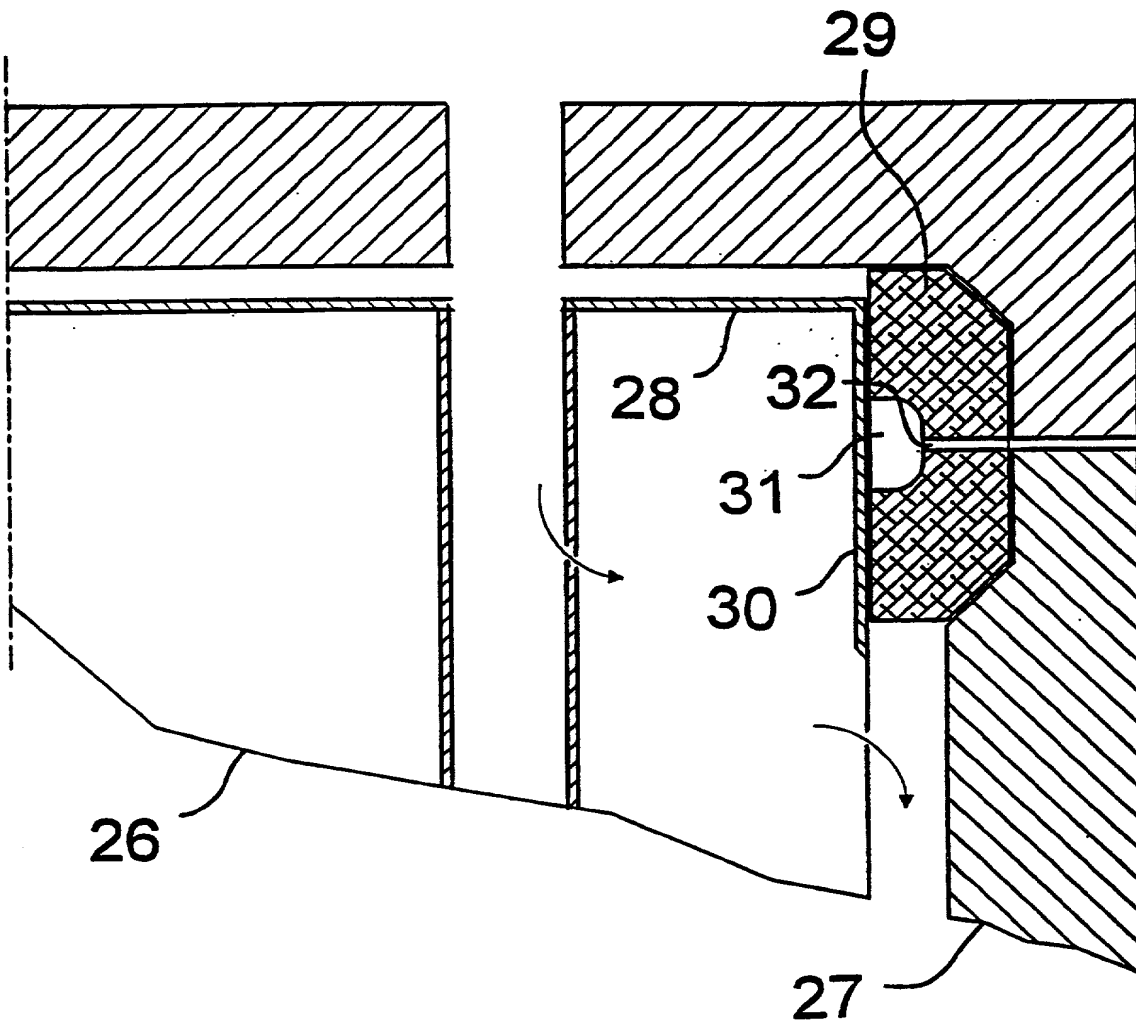


Fig. 7

-2-

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We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Docket No.: MED 2 1115

DECLARATION FOR PATENT APPLICATION

As the below named inventors, we hereby declare that:

Our residences, post office addresses, and citizenships are as stated below next to our names.

We believe we are the original, joint, and first inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

FILTERING UNIT AND METHOD OF SEALING SAME

the specification of which was submitted to the U.S. Patent and Trademark Office on January 8, 2002 and accorded U.S. Application Serial No. 10/030,738.

We hereby state that we have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

We hereby claim foreign priority benefits under Title 35, United States Code § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Priority Finland Patent Application No. FI-991576,
Filed July 9, 1999 in Finland.

Entry of PCT/FI00/00556; Filed June 21, 2000

We hereby claim benefit under Title 35, United States Code § 119(e) of any United States provisional applications listed below:

None

We hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112. We acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

None

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04 May 02

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)	Confirmation: 8284
I.A. Filed: June 21, 2000)	
)	
For: FILTERING UNIT AND)	
METHOD OF SEALING SAME)	
)	
Date of Notification:)	
March 27, 2002)	
)	
Attorney Docket No.:)	Cleveland, OH 44114
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RESPONSE TO NOTIFICATION OF MISSING REQUIREMENTS
UNDER 35 U.S.C. 371 IN THE UNITED STATES
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Assistant Commissioner
 For Patents
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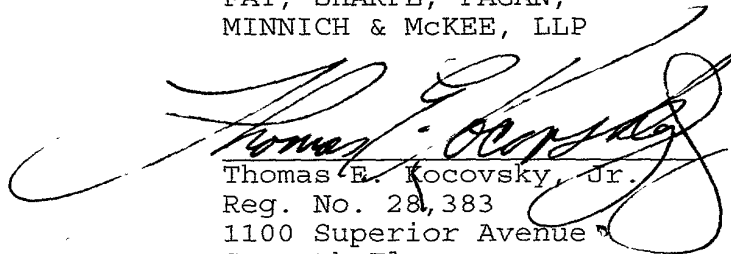
Dear Sir:

In connection with the above-entitled case, please find enclosed: (1) the Patent Office return copy of the Notification of Missing Requirements Under 35 U.S.C. 371 in the United States Designated/Elected Office (DO/EO/US) issued March 27, 2002; (2) the Declaration For Patent Application for U.S. Application Serial No. 10/030,738; and (3) the 37 C.F.R. 1.16(e) Surcharge of \$130.00.

The Commissioner is hereby authorized to charge any additional fees which may be required, or to credit any overpayment to Deposit Account No. 06-0308.

Respectfully submitted,

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